DOCUMENT RESUME

ED 191 932 UD 020 749

AUTHOR Ledvinka, James; And Others
TITLE Forecasting Minority Employment by Simulating the Long-Range Impact of "Fair Selection" Standards.
PUB DATE 1 Sep 79
NOTE 40p.: Paper presented at the Annual Convention of the American Psychological Association (New York, NY, September 1, 1979).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Black Employment; Blacks; Employment Projections; Employment Statistics; *Equal Opportunities (Jobs); *Federal Regulation; Labor Market; Occupational Mobility; *Personnel Selection; *Predictor Variables; *Quotas; Statistical Analysis

ABSTRACT

A labor force mobility model was developed to forecast the impact of several alternate statistical definitions of "fairness" in selection on minority employment. With data from an existing organization as a starting point, those forecasts showed that the definition of fairness in Federal regulations (Cleary's regression model) would have a worse effect on black employment than the implicit definition of fairness typically used by employers (a variation of Thorndike's constant ratio model). Other forecasts are presented, including the predicted impact of two hiring quota systems on black employment. Implications for Federal regulation are included. Statistical data are presented in tables and within an appendix. (Author/MK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

JUN 1 0 1980

ED191932

FORECASTING MINORITY EMPLOYMENT BY SIMULATING THE LONG-RANGE IMPACT OF "FAIR SELECTION" STANDARDS

James Ledvinka, Val H. Markos, and Robert T. Ladd

University of Georgia

American Psychological Association Convention

New York

September 1, 1979

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

James Ledvinka

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

The design for this research received the 1978 James McKeen Cattell Award from Division 14 of APA.

The authors gratefully acknowledge the advice of Lyle Schoenfeldt, Frank Schmidt, Frank Krzystofiak, George Milkovich, Thomas Mahoney, Hugh Watson, and Jorge Mendoza in the preparation of this paper.

Val H. Markos is now with United States Steel Corporation, Pittsburgh, Pennsylvania.

UD 020749

FORECASTING MINORITY EMPLOYMENT BY SIMULATING THE LONG-RANGE IMPACT OF "FAIR SELECTION" STANDARDS

When policy is oblivious to methodology, the results can defeat the purposes of the policy. The research here combines two methodological areas to forecast the results of alternative equal employment policies, including the policy that is currently written into the federal regulations. The first methodological area, psychological measurement, is used to define the alternative policies precisely. The second area, labor force modeling, is used to forecast the long-range impact of those alternatives on minority employment. The findings indicate that the policy in the federal regulations will, if obeyed, have results wholly unanticipated by those that wrote the policy.

Specifically, the equal employment policy alternatives under consideration are the various alternative definitions of "fairness." Several definitions have been advocated; one of them has been incorporated into the Uniform Guidelines on Employee Selection, which govern most employment in the country. Measurement methodology allows those definitions to be expressed in precise mathematical terms, and thus the definitions have been debated in the literature principally on the basis of their mathematical properties.

But the issue is as much a political one as a psychometric one. Analysis shows that the definitions differ in the passing scores they establish for the different race groups. In other words, some definitions make it harder than others for blacks to get hired, and black employment is a political objective. But there are other objectives as well, namely merit hiring and employee productivity, and different definitions of "fairness" may have different outcomes for each objective. The task of policy makers is to decide the relative desirability of those outcomes.

However, the long-range outcomes for minority employment are unknown. Forecasting long-range employment outcomes is the province of labor force modeling, the second methodological area. The research here uses a labor force mobility model to forecast the long-range impact on minority employment of making personnel decisions in accordance with the alternative definitions of fairness.

Fair Selection: A Brief Review of the Definitions

Table 1 presents five major definitions of fair selection that have been proposed in the literature (see Cole, 1973; Petersen & Novick, 1976; Hunter & Schmidt, 1976), along with their equivalent mathematical expressions in correlational terms (Darlington, 1971) and "decisional" terms (Petersen & Novick, 1976).[1]

Insert Table 1 about here

The regression model is the definition mandated by the federal regulations, and it is the most widely accepted of the five. Attributed to Cleary (1968), this definition has been the choice of most psychometricians (Linn, 1973; Schmidt & Hunter, 1974). Interestingly, it was those measurement specialists that were concerned with race discrimination who first advocated the regression model, (Barrett, 1965; Guion, 1966; Kirkpatrick, Ewen, Barrett, & Katzell, 1968), and EEOC's staff psychologist regarded that model approvingly (Enneis, 1970a, 1970b).

Accordingly, the regression model was adopted by the EEOC in their 1970 guidelines on employee selection and by the other federal EEO agencies in their 1976 joint guidelines (Schmidt & Hunter, 1974; Hunter, Schmidt, & Rauschenberger, 1977).[2] Finally, it was included in the recently published uniform federal employee selection guidelines, which have been adopted by all federal EEO agencies. The definition is alluded to and paraphrased repeatedly in the guidelines, perhaps most clearly in the following passage:[3]

> If unfairness is demonstrated through a showing that members of a particular group perform better or poorer on the job than their scores on the selection procedure would indicate through comparison with how members of other groups perform, the user may either revise or replace the selection instrument in accordance with these guidelines, or may continue to use the selection instrument operationally with appropriate revisions in its use to assure compatibility between the probability of successful job performance and the probability of being selected.

This definition applies to all selection procedures that are justified by criterion-related validty studies. By inference the definition applies as well to all procedures that are justified by construct validity studies,[4] and all that involve validity generalization across units in a multiunit organization.[5] Therefore, if enforced literally, the guidelines make the regression model mandatory for a major part of personnel selection.

The notion that the regression model would further the objective of minority employment stemmed from the belief that a single regression line for blacks and whites would underpredict black job performance (see, e.g., Barrett, 1965; Wallace, Kissinger & Reynolds, 1970; Enneis, 1970b). Ironically, it turns out that a single regression line usually overpredicts black job performance, for reasons discussed by Thorndike (1971) and Linn and Werts (1971). Thus the regression model usually necessitates using separate regression lines that effectively lower black scores (see Hunter, Schmidt, & Rauschenberger, 1977). As Thorndike (1971) first pointed out, the regression model usually leads to an underemployment of minorities when compared with the employment levels that would obtain if the employer had a perfect measure of applicant qualifications. As an alternative, Thorndike proposed the constant ratio model, which insures that the percent employed equals the percent "qualified." The conditional probability model was introduced by Darlington (1971) and advocated by Cole (1973).

The two remaining definitions have not been advanced very seriously in the measurement literature, but they have been imposed in various circumstances by the federal courts and agencies. What is referred to here as the "culture-free"

model is often referred to in the literature as the "quota" model (Darlington, 1971; Cole, 1973; Hunter & Schmidt, 1976). But the courts and agencies frequently have something entirely different in mind when they impose quotas, thus the two are distinquished here. Statistically, the quota model reduces to the culture-free model with the minority representation in the applicant pool arbitrarily set equal to the desired quota figure.[6]

Despite the federal mandate for the regression model, employers generally disregard it.[7] Instead, they implicitly use a definition of fairness that makes no distinction between black and white scores. All criterion scores are combined and regressed on all predictor scores, resulting in a single regression equation. This straightforward, pre-EEO approach might be called the color-blind model. It differs from the regression model in that it does not adjust predictor scores to compensate for the difference between black and white intercepts. It wholly disregards race as a variable. For practical purposes, it is similar to the constant ratio model. (See Appendix A for further discussion of the color-blind model.)

Other definitions of fair selection have also been proposed, including models in which selection decisions are a function of the utilities of various selection outcomes (Gross & Su, 1975; Petersen & Novick, 1976; Sawyer, Cole, & Cole, 1976). Such models are the only vehicle for incorporating value judgments about the relative desirability of various outcomes. However, those judgments are limited to immediate selection outcomes. The user is asked to decide such matters as the relative undesirability of majority false negatives and minority false negatives. The interests of social policy makers turn more to long-range questions of cumulative impact: What is the ultimate effect of a given fair selection standard on minority employment? What is its ultimate effect of the economic status of American industry and the productivity of the American labor force?

This research concerns the effects on minority employment. It is well established that different fair selection standards have different immediate outcomes for minority employment (Cole, 1973; Breland & Ironson, 1976; Hunter, Schmidt, & Rauschenberger, 1977); this research would project the long-range consequences of those outcomes.

Labor Force Mobility Models: A Brief Review

It is useful to distinguish two kinds of quantitative labor force models, demand models and supply models. Labor demand models project the number of employees that the organization will require in eacn job classification;[8] labor supply models project the organization's capacity to meet a given level of demand through its staffing process. The modeling task in the proposed research is to simulate supply.

A variety of supply modeling approaches have been proposed: linear programming (Patz, 1970), dynamic programming (Nemhouser & Nuttle, 1965), network analysis (Bonham, Clayton, & Moore, 1975), simulation of superior-subordinate relationships (Miller, 1970), and, most common of all, Markov modeling.

Markov modeling of labor mobility has been in existence for some time (see Blumen, Kogan, & McCarthy, 1955). Markov models work by simulating movements of people through "states" (job classes) over successive "stages" (time periods) as a stochastic process, (Dill, Gaver, & Weber, 1966; Haire, 1968; Vroom & MacCrimmon, 1968; Rowland & Sovereign, 1969; Mahoney & Milkovich, 1971; Nielsen & Young, 1973). In other words, a Markov model can forecast the internal supply (I) of workers for job class j at time t=1. Those forecasts are based on two sets of parameters: the staffing levels (S) in each job class i at time t=0, and the estimated proportions (or transition probabilities) of workers in each job class i that portions (or transition probabilities) of workers in each job class i that move to j between t=0 and t=1:

$$I_1(j) = \sum_i S_0(i)P(j|i) \qquad (1)$$

The basic properties of Markov processes permit the extension of this forecast for n stages into the future by taking successive powers of the i x j matrix of transition probabilities. However, this does not incorporate employees hired into the organization between t = 0 and t = n: the external supply.

To incorporate external supply, Vroom & MacCrimmon (1968) concatenated a series of n single-stage Markov chains, with new hiring inputs at the end of each chain. In other words, after computing the first stage internal forecast, they took the difference between that and the anticipated overall staffing level for job class j at time 1 ($S_1(j)$) to find the number of new hires needed between t = 0 and t = 1. Then they recursively applied the transition probabilities to the n successive anticipated staffing levels, thus simulating both internal and external contributions to the labor force for n periods. Not only can this model forecast recruiting needs, but also it can be used to simulate various staffing programs and policies by manipulating the transition probabilities to reflect the anticipated impact of the program or policy in question.

The single-stage Markov approach has also been extended to the problem of forecasting the labor supply of different sex and ethnic groups (Ledvinka, 1975; Milkovich & Krzystofiak, 1977). This approach disaggregates the labor force by group membership (c):

$$I_1(cj) = \sum_i S_0(ci)P(j|i,c) \qquad (2)$$

To compute external hires (E_1) from each sex and ethnic group, the $I_1(cj)$ forecasts are reaggregated over groups, and:

$$E_1(j) = S_1(j) - \sum_c I_1(cj), \; I_1 \leq S_1 \qquad (3)$$

The $\sum_c E_1(cj)$ external hires are then apportioned among groups on the basis of the previous year's hiring experence:

$$E_1(cj) = E_1(j) \; E_0(cj)/\sum_c E_0(cj) \qquad (4)$$

Finally, the total forecasted staffing level of each sex and ethnic group is computed:

$$S_1(cj) = I_1(cj) + E_1(cj) \qquad (5)$$

Multi-stage Markov models for simulating work-force integration have also appeared in the literature (Churchill & Shank, 1976), as have work-force integration models that embed Markov processes within a goal programming framework (Charnes, Cooper, Lewis, & Niehaus, 1976). Apparently, such models are accepted tools of affirmative action planning in many large corporations (Chew & Justice, 1977; Dyer & Wesman, 1977).

Method

Integrated Models of Fair Selection and Labor Force Mobility

To forecast the outcomes of the fair selection standards, those standards must be integrated with a labor force mobility model. The discussion of labor force mobility models identifies two types of selection decisions, internal and external. An organization may adopt a given fair selection standard in its external selection (new hires), in its internal selection (promotions, demotions, and transfers), or in both internal and external selection.

It seems reasonable to say, at least for purposes of discussion, that most organizations would adopt fair external selection procedures before they adopt fair internal selection procedures. External hiring decisions can be based on explicit predictor scores more readily than can internal mobility decisions, which are often governed by seniority and tradition. Thus an integrated model is used to simulate the consequences of two types of fair selection decisions: (a) fair external selection, and (b) fair internal and external selection.

In the external integrated model, the external hires component of equation (5) above is apportioned between minorities and nonminorities in accordance with a fair selection standard instead of in accordance with equation (4). Otherwise, the external integrated model is the same as equation (2) through (5) above. In the internal/external integrated model, external as well as internal supplies are apportioned between minorities and nonminorities in accordance with a fair selection standard. The aggregated internal supply across groups is determined by equation (1), and the minority/non-minority composition of that supply is determined by the fair selection standard.

To operationalize the two integrated models, the proportions of minorities and non-minorities in the internal and external supplies must be determined for each fair selection standard. These proportions are determined by whatever cutoff score on the selection instrument simultaneously provides the required supply -- $I_1(j)$ for internal supply, $E_1(j)$ for external supply -- and satisfies the fair selection standard in question.

Calculating Group Cutoffs and Selection Ratios. The cutoff score is determined by four parameters: (1) the validity of the selection instrument (r_{xy}), (2) the difference between minority and non-minority group means on the criterion measure, (3) the proportion of minorities in the applicant pool, and (4) the proportion of applicants selected (the selection ratio). Parameters (1) and (2) operate to define the black-white difference in predictor cutoff scores, and parameter (3) operates to determine where along the predictor-score axis the two cutoffs must be placed in order to provide the supply indicated by parameter (4).

Hunter, Schmidt, & Rauschenberger (1977) present a method for calculating this cutoff. Their method begins with the recognition that each "fairness" definition implicitly establishes a black-white cutoff difference in terms of parameters (1) and (2). If Δ represents the criterion mean difference between

groups ($\bar{Y}_w$-$\bar{Y}_b$), and if d represents the predictor mean difference between groups ($\bar{X}_w$-$\bar{X}_b$), then selection with a common cutoff score is considered fair if:

$d = \Delta/r_{xy}$ by the regression model (6)

$d = \Delta$ by the constant ratio model (7)

$d = r_{xy}\Delta$ by the conditional probability model (8)

$d = 0$ by the culture-free model.[9] (9)

In other words, to satisfy the fair selection standard in question, scores on the selection instrument would have to be adjusted so as to produce the indicated differences between group means on the selection instrument. The cutoff score refers to those adjusted scores. The derivation of predictor mean differences is presented in Appendix A.

The cutoff score (x*) is then found by minimizing the absolute value of:

$$f(x^*) = p_w q_w(x^*) + p_b q_b(x^*) - s_{(w+b)}$$

where p = proportion of the applicant pool that belongs to the indicated group, q = the proportion of those in the indicated group that are selected (given x*), and s = the proportion of applicants that are selected. The subscripts w and b refer to non-minorities and minorities respectively. Values of p and s are given; values of q are found by determining the area under the unit normal curve above x=x*.

An iterative procedure is used to determine x*:

$$x^*_{(n+1)} = x^*_n - f(x^*_n)/f'(x^*_n)$$

where f' is the derivative of f, and the subscripts refer to successive iterations. Hunter, et al. (1977) suggest using the average of the two single group cutoff scores as an initial approximation for x* in the above equation. Iterations continue until the difference between x^*_n and x^*_{n+1} is essentially zero, and the resulting value of x* determines the value of q.

Incorporating Group Selection Ratios into the Forecasting Model. The incorporation of the q values in the external model is straightforward; the incorporation of those values in the internal/external model bears explanation. Internal labor force movements are determined by transition probabilities that are not disaggregated by group membership -- as in equation (1) above. The job classes are ordered for purposes of distinguishing promotions and demotions. The group composition of those promoted out of job class i -- $\sum_j I_1(cij)$, $j>i$ -- is determined by applying the fair selection standard under consideration to the pool of workers in job class i. This means that group transition probabilities can vary from year to year. The group composition of those demoted out of i ($j<i$) is determined by similarly applying the fair selection standard under consideration, but with selection beginning from the bottom of the distribution of scores on the selection device instead of from the top. Operationally, this means that in simulating demotions the criterion mean difference between the two groups carries the opposite sign from what it carries in simulating promotions and transfers.

The destination job class j of promotees from job i is determined by:

$$I_1(cij) = \frac{P(j|i)\sum_j I_1(cij)}{\sum_j P(j|i)}, \quad j>i$$

where $P(j|i)$ is the probability of a person in i being promoted to j. The same equation governs $j<i$. Terminations for each group are determined using transition probabilities disaggregated by group (c), as in equation (2).[10]

The Model Program

A computer program was written to implement the integrated model. This program allows the user to:

1. choose between the external model and the internal/external model.
2. choose a range and increment for variation of the following parameters:
   a. criterion mean difference (Δ).
   b. validity of the selection procedure (r_{xy}).
   c. selection ratio ($s_{(w+b)}$).
   d. proportion of blacks in the applicant pool (p_b).
3. choose a fairness definition.
4. vary the parameters over time (some parameter variation is integral to the internal/external model).
5. display the results over any chosen time horizon in tabular or graphic form.

In short, the program is more a model-building program than a program of a model.

Parameter Estimation

The integrated model does not require parameter values to be empirically established--indeed, it is a strength of the model to be able to simulate variation in parameter values. As a practical matter, however, some parameters should be fixed empirically. Otherwise, the number of independent variables becomes unmanageable. Transition probabilities are especially numerous: if n equals the number of job classes, then there are $2n(n+1)$ transition probabilities. Besides, many potential applications of the model would involve specific organizations with specific, empirically identifiable rates of movement among job classes.

Accordingly, an organization was chosen, and transition probabilities were extracted from its computerized personnel records. The organization was a department of state government with about 1000 employees. The department provided staff services to the rest of state government. The large majority of employees were white collar workers, with the largest job classification being that of keypunch operator. The department's personnel records allowed a determination of movements each employee made between job classes during a given one-year time period. From that information, a complete enumeration of personnel movements was developed, and the transition probabilities were computed from that enumeration. This procedure was followed for each of two successive years, the longest span of time for which data were available. Each transition probability, $P(j|i,c)$, was set equal to the mean of the two one-year transition probabilities for each $j|i,c$ element. The initial staffing levels, $S_0(ci)$, were also set equal to the mean of the two one-year figures. For purposes of simplification, anticipated staffing levels, $S_1(j)$, were assumed to remain constant over the planning horizon at a level equal to the mean initial staffing level for the job class, j.

Table 2 presents the staffing levels and transition probabilities. These figures include two changes that were made in the observed values in order to make them logical. One change was to devise a set of transition probabilities for blacks in the official/administrator category, since no blacks had served in that category before. The white transition probabilities for officials and administrators was used. The other change was to reduce the probability of black professionals remaining professional from 1.000 to .950, since all individuals must inevitably terminate their employment. The figure of .950 was chosen arbitrarily; probability of black professionals terminating was set equal to .050.

Insert Table 2 about here

The proportion of minorities in the applicant pool (p_b) was estimated from labor market data. The State Department of Labor provided the department with estimates of labor availability for affirmative action planning purposes. These showed the overall proportion of minorities in the labor market to be .225.

The remaining parameters were varied instead of being empirically estimated. This allowed forecasts to be generated for the more realistic combinations of parameter values. Following Hunter, Schmidt, and Rauschenberger's review of the literature (1977), the criterion mean difference (Δ) was assumed to be 0.5 s.d. in favor of whites; a value of 0.0 s.d. was also examined. Validity (r_{xy}) was set at values of .30 and .50. The selection ratio was set at values of 0.2 and 0.5.

Results

The results to date are preliminary, for the research is continuing. Further modifications are being made in the computer model, and further forecasts are being carried out. Still, some of the preliminary findings are noteworthy, especially in their implications for government policy.

Two sets of forecasts are especially significant. One compares the minority employment levels that result from using two particularly important definitions of "fairness", the regression model and the constant ratio model. This comparison is significant because the regression model is the definition mandated by federal regulations, while the constant ratio model is the definition that comes closest to the color-blind definition generally used by employers. In fact, when Δ is changed to d, the constant ratio model becomes the color-blind definition. The second set of forecasts is the minority employment levels that result from hiring quota systems. Those are significant because quotas are such a common element in both voluntary and court-ordered affirmative action plans.

The first set of forecasts appears in Table 3. These figures compare the regression and constant ratio definitions over a 30-year horizon using the internal-external integrated model. All forecasts reached 95% of their asymptotic levels within that period.

Insert Table 3 about here

Table 3 shows that the regression model has a more severe impact on black employment than the constant ratio model for all values of r_{xy} and $s_{(w+b)}$. The relative severity of the regression model increases as those two parameter values decrease. The forecasts for the regression model are more sensitive to variation in parameter values--indeed, the constant ratio model is totally insensitive to variation in r_{xy}, since r_{xy} is not a parameter in that definition. The regression model is more sensitive to the 0.2 variation in r_{xy} than to the 0.3 variation is $s_{(w+b)}$. In all of these respects, the findings parallel the short-run simulations of Hunter, Schmidt, and Rauschenberger (1977).

What is new about the present findings in Table 3 is the seemingly hopeless disadvantage suffered by blacks in some jobs at the hands of the regression model.

The regression model seems to do its worst damage to blacks in the very job classes where blacks have the lowest initial employment levels. The most extreme case is a realistic, perhaps even typical, situation: professionals at $r_{xy} = 0.3$ and $s_{(w+b)} = 0.2$. There the constant ratio model produces a black employment level 41.5 times that of the regression model. Using the regression model results in a decrease in black professional employment from an already low 0.6% to 0.1%. Such findings are not intuitively apparent from earlier research.

Table 4 is a set of forecasts that apply to a broad range of situations: (a) all cases where $\Delta = 0$, and (b) all cases where the culture free definition is used. This convergence is apparent from equations (6) through (9): assuming that no criterion differences exist between blacks and whites is tantamount to equalizing the selection ratios between them. The result is a dramatic improvement in black employment. Still, the improvement is not immediate but gradual over the planning horizon, and the degree of improvement differs notably among job classes.

Insert Table 4 about here

While Table 4 is a "quota system" forecast, in that the culture free definition implies that minorities will be selected in proportion to their representation in the applicant pool, other sorts of quota systems are more likely to be found in practice. Most quota systems require that the employer hire minorities in fixed proportions. Such quota systems can be simulated by means of the external integrated model. Table 5 shows the forecasts from that simulation for two quota proportions, .225 and .500. The .225 condition represents population based quotas; the .500 condition represents a more stringent "one black for every white" quota.

Insert Table 5 about here

It comes as no surprise that a .500 quota ratio produces more pronounced improvements in black employment. Still, it would take at least six years under that quota to bring the black employment in all job classes of this organization up to the population parity figure of .225. This is noteworthy in light of the fact that the federal government (namely OFCCP) operates under the expectation that minority underutilization will be remedied within five years.[11] All other things being equal, OFCCP will have to lengthen its time horizons or employers will have to adopt more stringent quota systems, if expectations are to be met in this area.

Discussion

Using the Program to Build Better Models

Many reservations can be raised about these findings: Is the organization representative? Is the choice of .225 as a p_b value realistic? Is Δ truly constant at 0.5 over time? Is it realistic to hold the selection ratio constant across job classes? Other objections are conceivable as well.

Yet the model's capacity for change allows it to answer those reservations. If one questions the assumptions underlying the findings here, other assumptions can usually be substituted, and findings under those new assumptions can be examined. This is particularly true in regard to parameter values. For example, anticipated staffing levels can be made to vary, and transition probabilities can be set by extrapolating from several years' previous data instead of by assuming that the immediately preceding year's values remain constant over the forecasting period. Also, any given transition probability can be altered for whatever reason the user may have. In addition, parameter values assumed to be equal between job classes can be varied, so that, for example, a user can assume a larger criterion mean difference for higher level jobs than for lower level ones.

Moreover, many parts of the internal structure of the model can be altered through reprogramming. The main value of the model is that the user can manipulate it to suit his situation. For example, the application of fair selection standards to demotions in the internal/external model could be altered to meet different assumptions about an employer's staffing patterns. While it might be argued that such alterations actually entail different models from the ones proposed here, the principal contribution of this area of research would seem to lie not in the specific assumptions about labor force behavior made by a particular realization of the modeling procedure, but instead in the paradigmatic value of the modeling procedure as a basic strategy for simulating whatever assumptions one wishes to make about labor force behavior.

The model can also be used to produce some potentially useful by-products. For example, it can be used to forecast the amount of time necessary to attain a predetermined parity representation of minorities under the various fair selection standards. Also, by simulating the impact of a quota system, it can allow a court or agency to evaluate whether the imposition of a quota system can be justified in light of its benefits in integrating the work force.

Limitations, Real and Imaginary

Certain limitations of this research should be mentioned. Some appear to be imaginary or at least of secondary importance; others are real but can be mitigated.

Parameter stability. Parameter stability is of importance only insofar as it affects the estimates of the dependent variable, labor force integration. Given the model's mission of forecasting integration under various policy conditions, instability of process can be forgiven if the model displays

stability in its product. Indeed, there is reason to suspect that event-by-event predictions in models such as this are usually "underdetermined" and thus rather unstable, yet that kind of instability would not necessarily affect the model's outcomes (see Abelson, 1968). It should be remembered that each integration forecast is a marginal based on as many i x j cells as there are job classes. In short, the proper focus of a concern over validity is with the accuracy of the forecasts of labor force integration.

Possible biases. Fararo's discussion (1973, Ch. 16) raises the possibility of inaccurate forecasts in Markov labor force simulation. One problem, the underprediction of "staying" (j=i) turns out to be a bias introduced by the matrix manipulations in multi-stage Markov models; it is not a problem in single-stage simulations such as the one here. Other matters may not be so easily dismissed. For example, the assumptions that labor mobility is constant and path-independent (i.e., independent of workers' history of previous movement among states) seem particularly questionable. This is an empirical issue that can be addressed in the validity study suggested below.

The hypothesis of accuracy. Even so, there is little reason for concern over the inference of validity or invalidity of the forecasts. Instead, the concern of policy makers would be over the degree of accuracy, or the confidence with which one can say that alternative policies have different outcomes Moreover, that concern is limited to the internal labor force component of the model: the validity of the fair selection component is not at issue, because adherence to a fair selection standard is given in each simulation.

Validity study: The measurement of accuracy. This suggests a validity study that would compare forecasted and actual integration levels over as many years as the data base covers. Clearly, this would require more than the two years' data presently available from the department studied here. From an n-year data base, a Monte Carlo simulation could be used to produce confidence intervals for the forecasts.

To test the external model, transition probabilities in the Monte Carlo simulation would be chosen at random for each i,j pair and each group c from the n-year distribution of $P(j|i,c)$. Each of the n values of $p(j|i,c)$ would be additively adjusted such that the mean of the n-year distribution would equal $p(j|i,c)$ for year 1. The resulting values would then be multipled by $1/\sum_j P(j|i,c)$ to satisfy $\sum_j P(j|i,c)=1.0$. The value sampled from each of the distributions in the Monte Carlo study would remain constant over the forecasting horizon. Since the anticipated staffing levels and the selection ratio for external hires are exogenous to the labor force mobility model, they would be set equal to empirically observed values. The resulting distribution of forecasts for each job class would measure the robustness of the model in a way that would allow a policy maker to determine the confidence with which he can make a forecast. And the validity study assesses bias as well, because it is a retrospective forecast that can be compared with actual integration levels.

For the internal/external model, the validation would be identical, except that the transition probabilities would not be disaggregated by group. Instead, since the selection ratio for the internal component as well as the external component is exogenous in the internal/external model, it would be set equal to empirically observed values.

If it turns out that the proposed model produces biased forecasts, alternative stochastic modeling strategies can be considered, as discussed in Bartholomew (1973). Some likely alternatives are mover-stayer models (Blumen, Kogan, & McCarthy, 1955), semi-Markov models (Valliant & Milkovich, 1977), and vacancy-chain models (White, 1970).

"Freezing" in the internal-external model. The internal-external model makes a critical assumption: "fair selection" affects only the group composition of the employees moving out of job class i, not the total number of employees moving. If all the i source job classes for job class j were 100% white, then the

internal movement into j would be 100% white, even if other potential source job classes had blacks in them. This means that the model would "freeze" the status quo in much the same way that seniority systems illegally froze the status quo in early EEO cases.[12]

"Freezing" is a problem only where there is unequal distribution of groups among potential source job classes for a given destination job class. Of course, an employer can adopt any definition of fairness even with this "freezing," but it strains semantics to call the end result "fair selection."

To unfreeze the model, the job classifications must be job related.[13] In other words, distinctions among jobs having different group compositions cannot be artifical ones. In the present research, those distinctions are apparently quite real, for the job classes are quite broad, whether they are job related is less certain. It is up to the user of the model to insure job relatedness, perhaps with a method such as Dunnette's (1977).

Conclusions

While the results are preliminary and raise many questions, it seems justified to draw two important conclusions from them. The first is that minority underemployment persists indefinitely except when blacks and whites have equal criterion means or when some form of quota system is used. And even when black and white criterion means are assumed to be equal, as in Table 4, blacks remain underemployed for a generation or longer in the higher job classes. The 50% quota is the only condition in the present findings that eliminates minority underemployment in all job classes within a period of time anywhere near what the federal government expects, and even that condition would require forbearance on the part of blacks.

The second conclusion is that the definition of "fairness" in the federal regulations would, if followed, result in a severe erosion of minority employment.

Left to their own devices, employers implicitly choose a definition that is better for minority employment.

The implications of that observation are particularly significant in light of the Sears lawsuit against the federal regulatory agencies. The suit claimed that federal regulation of employment was internally contradictory: while some regulations forced Sears to increase minority and female employment, other regulations (e.g., veterans' affirmative action) tended to vitiate any progress Sears made. Sears lost the suit in court, but they may have won it in the court of public opinion, for the commentary in the media was profuse and generally sympathetic.

The findings here lend support to the notion that there is something awry in federal regulation. Like the Sears suit, the findings here indicate that regulation is having some unintended consequences. It is unsettling to find that the constant ratio model is 41.5 times better than the regression model for black professional employment when the selection ratio and validity are low. Clearly, the federal EEO agencies did not intend that their definition of fairness hurt minorities--in fact, there is abundant reason to believe that they wrote the definition the way they did in 1971 precisely because they believed it would help minorities (Ledvinka, 1979). Apparently they did not realize the technical implications of what they were writing. In fairness, nobody else seemed to realize them either; it was not until 1971 that Thorndike (1971) and others began to point them out. Still, the agencies have repeatedly reaffirmed their definition of fairness, most recently on March 2, 1979.[14] One might have expected them instead to underwrite a thorough study of the long-range impact of various "fairness" definitions (on employee productivity as well as minority employment) and act accordingly in rewriting their regulations. With agency sponsorship, there is no reason why the findings here could not have been discovered seven years ago.

The implications of the findings here are also noteworthy in light of the Supreme Court's Weber opinion,[15] which upheld a voluntary quota system. The Court's reasoning was that Congress, in passing Title VII of the 1964 Civil Rights Act, intended to support policies that result in black employment gains. By implication, that reasoning argues strongly against the fairness definition in the regulations. For management, the message is clear: beware of the regulatory bind in criterion-based employee selection. The employee selection regulations require that criterion-based selection must adhere to the regression definition, which produces underemployment among minorities. On the other hand, the affirmative action regulations require that employers make "good faith" efforts to eliminate the underemployment of minorities.[16] Now Weber, by emphasizing minority employment as an objective, increases the pressure on employers to abandon criterion-based selection. This could spell the end of most employment testing as it is known today.

None of that need occur, however. The federal agencies could, if they chose, abstain from mandating a definition of fairness pending assessment of the benefits and costs of the alternative approaches to the issue of fairness. Such an assessment would begin with the continuing high black-white differences in the employment and earnings statistics (U. S. Commission on Civil Rights, 1978). This persistent economic inequality should lead observers to ask how the employee selection process contributes to the problem. It seems logical for psychologists and policy makers alike to inquire into prevailing employment practices and especially into the fair selection standards that are implicity embodied in those practices. What are the alternatives? How well would they work to reduce inequalities? How much of an upheaval in employment practices would it take to solve the problem in a reasonable length of time? If policy makers have not been asking these questions, perhaps they will now that there is a way to get answers.

FOOTNOTES

[1]The development of these models assumes an unbiased criterion measure, no differential validity, and the distributional conditions necessary for a linear regression analysis. For the sake of simplicity, it also assumes equal variance between groups on both predictor and criterion. The recent resurrection of concern over the existence of differential validity is noted (Bartlett, Bobko, & Pine, 1977; Katzell & Dyer, 1977, 1978; Hunter & Schmidt, 1978). Nevertheless, the federal selection guidelines (see footnote 2 below) require equal validity.

[2]The EEOC guidelines section is at 20 C.F.R. § 1607.5(b)(5), the other agencies' guidelines section is at 41 C.F.R. § 60-3.12(b)(7)(iv), and the uniform draft guidelines section is at 42 Federal Register 65542 (December 30, 1977).

[3]Sec. 14.B(8)(d), Uniform Guidelines on Employee Selection Procedures, 45 Federal Register 38290 (August 25, 1978). Also see Question 67 of the Questions and Answers on the Uniform Guidelines, (March 2, 1979).

[4]Sec. 14.D(3), Uniform Guidelines.

[5]Id., Sec. 7.C.

[6]A measure of qualifications can still be used in the quota model to govern selection within each group.

[7]American Society for Personnel Administration, Fair Employment Digest, June 1978.

[8]For examples of demand forecasting methods, see Drui (1963), Morton (1968), and Wilkerson (1976).

[9]For the color-blind model, there is no adjustment to predictor scores. See Appendix A.

[10]The probabilities could also be aggregated if there is a reason to suspect discriminatory discharge practices in the organization.

[11]Affirmative Action Plan Workbook for Federal Contractors (New York: Executive Enterprises, Inc., 1979), p. 105. However, there is some evidence that OFCCP may be altering its position. In its draft of nationwide affirmative action standards for banking appears the following:

> When the long range goal cannot be reached withing 5 years despite a [quota ratio] of 50%, the [quota ratio] will remain at 50% and a longer time frame established.

BNA Affirmative Action Compliance Manual, No.22, July 2, 1979 (Washington, D.C.: Bureau of National Affairs), p. 15.

[12]The best-known seniority cases were Quarles v. Phillip Morris, Inc., 279 F. Supp. 505 (U. S. Dist. Ct., Va., 1968), and Local 189, United Papermakers & Paperworkers v. U. S., 416 F.2d 980 (5th Cir., 1969, certiorari denied, 397 U.S. 919 (1970).

[13]Or seniority related, if one accepts the applicability of the Supreme Court's analysis in Teamsters v. U.S., 97 S. Ct. 1943.

[14] Question 67 of Questions and Answers (note 3 above).

[15] United Steelworkers of America v. Weber (U. S. Supreme Court, June 27, 1979).

[16]Secs. 60-2.10 and 60-2.12(g), OFCCP Affirmative Action Guidelines, 41 C.F.R. 60-2 (October 20, 1978).

REFERENCES

Abelson, R.P. Simulation of social behavior. In G. Lindzey & E. Aronson (Eds.), Handbook of social psychology (2nd ed., vol. 2). Reading, Mass.: Addison-Wesley, 1968. Pp. 274-356.

Barrett, R.S. Differential selection among applicants from different socio-economic or ethnic backgrounds. In Selection and training of Negroes for managerial positions. Princeton, N.J.: Educational Testing Service, 1965.

Bartholomew, D.J. Stochastic models for social processes (2nd ed.). London: Wiley, 1973.

Barlett, C.J., Bobko, P. & Pine, S.M. Single-group validity: Fallacy of the facts? Journal of Applied Psychology, 1977, 62, 155-157.

Blumen, I., Kogan, M. & McCarthy, P.J. The industrial mobility of labor as a probability process. Ithaca, N.Y.: Cornell University, 1955.

Bonham, R.W., Clayton, E.R., & Moore, L.J. A GERT model to meet future organizational manpower needs. Personnel Journal, 1975, 54, 402-406.

Breland, H.M., & Ironson, G.H. DeFunis reconsidered: A comparative analysis of alternative adminssions strategies. Journal of Educational Measurement, 1976, 13, 88-99.

Bright, W.E. How one company manages its human resources. Harvard Business Review. 1976, 54 (1), 81-93.

Center for Human Resources Research, Ohio State University, The national longitudinal surveys handbook. Columbus, Ohio: Author, 1976.

Charnes, A., Cooper, W.W., Lewis, K.A., & Niehaus, R.J. A multi-objective model for planning equal employment opportunities. In M. Zeleny (Ed.), Multiple Criteria Decision Making: Kyoto 1975. New York: Springer Verlag, 1975.

Chew, W.B., & Justice, R.L. AAP modeling for large complex organizations. Paper presented at the Cornell Conference on Affirmative Action Planning, Ithaca, N.Y., 1977.

Churchill, N., & Shank, J. Affirmative action and guilt-edge goals. Harvard Business Review, 1976, 54 (2), 111-116.

Cleary, T.A. Test bias: Prediction of grades by Negro and white students in integrated colleges, Journal of Educational Measurement, 1968, 5, 115-124.

Cole, N.S. Bias in selection, Journal of Educational Measurement, 1973, 10, 237-255.

Darlington, R.B. Another look at "cultural fairness." Journal of Educational Measurement, 1971, 8, 71-82.

Dill, W.R., Gaver, D.P., & Weber, W.L. Models and modelling for manpower planning. Management Science, 1966, 13, B142-B167.

Drui, A.B. The use of regression equations to predict manpower requirements. Management Science, 1963, 9, 669-677.

Dunnette, M.D. Task and job taxonomies as a basis for evaluating employment qualifications. Paper presented at the Cornell Conference on Affirmative Action Planning, Ithaca, N.Y., 1977.

Dyer, L., & Wesman, B. Case studies: AT&T and IBM. Paper presented at the Cornell Conference on Affirmative Action Planning, Ithaca, N.Y., 1977.

Enneis, W.H. Minority employment barriers from the EEOC viewpoint. In B.R. Anderson & M.P. Rogers (Eds.), Personnel testing and equal employment opportunity. Washington, D.C.: U.S. Government Printing Office, 1970. (a)

Enneis, W.H. Personnel testing and equal employment opportunity. In B.R. Anderson & M.P. Rogers (Eds.), Personnel testing and equal employment opportunity. Washington, D.C.: U.S. Government Printing Office, 1970. (b)

Fararo, T.J. Mathematical Sociology. New York: Wiley, 1973.

Gross, A.L., & Su, W. Defining a "fair" or "unbiased" selection model: A question of utilities. Journal of Applied Psychology, 1975, 60, 345-351.

Guion, R.M. Employment tests and discriminatory hiring. Industrial Relations, 1966, 5, 20-37.

Haire, M. Approach to an integrated personnel policy. Industrial Relations, 1968, 7, 107-117.

Hunter, J.E., & Schmidt, F.L. Critical analysis of the statistical and ethical implications of various definitions of test bias. Psychological Bulletin, 1976, 85, 1053-1071.

Hunter, J.E., & Schmidt, F.L. Differential and single-group validity of employment tests by race: A critical analysis of three recent studies. Journal of Applied Psychology, 1978, 63, 1-11.

Hunter, J.E., Schmidt, F.L., & Rauschenberger, J.M. Fairness of psychological tests: Implications of four defintions for selection utility and minority hiring. Journal of Applied Psychology, 1977, 62, 245-260.

Katzell, R.A., and Dyer, F.J. On differential validity and bias. Journal of Applied Psychology, 1978, 63, 19-21.

Kirkpatrick, J.J., Ewen, R.B., Bartett, R.S., & Katzell, R.A. Testing and fair employment. New York: New York University Press, 1968.

Ledvinka, J. Technical implications of equal employment law for manpower planning. Personnel Psychology, 1975, 28, 299-323.

Ledvinka, J. The statistical definition of fairness in the federal selection guidelines and its implications for minority employment. Personnel Psychology, 1979, in press.

Linn, R.L. Fair test use in selection. Review of Educational Research, 1973, 43, 139-161.

Linn, R.L., & Werts, C.E. Considerations for studies of test bias. Journal of Educational Measurement, 1971, 8, 1-4.

Mahoney, T.A., & Milkovich, G.T. The internal labor market as a stochastic process. In A.R. Smith & D.J. Bartholomew (Eds.), Manpower and management science. London: Heath, 1971.

Milkovich, G., & Krzystofiak, F. Human resource planning models and affirmative action planning. Paper presented at the Cornell Conference on Affirmative Action Planning, Ithaca, N.Y., 1977.

Miller, J.R., III. Micro-simulation as an aid to managing human resources. Industrial Management Review, 1970, 11 (2), 24-30.

Morton, J.E. On manpower forecasting. Kalamazoo, Mich.: W.E. Upjohn Institute, 1968.

Nemhouser, G.L., & Nuttle, H.W.L. A quantitative approach to employment planning. Management Science, 1965, 11, 158-165.

Nielsen, G.L., & Young, A.R. Manpower planning: A Markov chain application. Public Personnel Management, 1973, 2, 133-143.

Patz, A.L. Linear programming applied to manpower management. Industrial Management Review, 1970, 11, 31-38.

Petersen, N.S. & Novick, M.R. An evaluation of some models for culture-fair selection, Journal of Educational Measurement, 1976, 13, 3-31.

Rowland, K.M. & Soverign, M.G. Markov-chain analysis of internal manpower supply. Industrial Relations, 1969, 9, 88-99.

Sawyer, R.L., Cole, N.S., & Cole, J.W.L. Utilities and the issue of fairness in a decision-theoretic model for selection. Journal of Educational Measurement, 1976, 13, 59-76.

Schmidt, F.L., & Hunter, J.E. Racial and ethnic bias in psychological tests: Divergent implications of two definitions of test bias. American Psychologist, 1974, 29, 1-8.

Thorndike, R.L. Concepts of culture fairness. Journal of Educational Measurement, 1971, 8, 63-70.

U. S. Commission on Civil Rights. Social indicators of equality for minorities and women. Washington, D.C.: Author, 1978.

U.S. Department of Commerce, Bureau of Economic Analysis. Regional work force characteristics and migration data: A handbook on the Social Security Continuous Work History Sample and its application. Washington, D.C.: U.S. Government Printing Office, 1976.

Valliant, R., & Milkovich, G. Comparison of semi-Markov and Markov models in a personnel forecasting application. Decision Sciences, 1977, 8, 465-477.

Vroom, V.H., & MacCrimmon, K.R. Toward a stochastic model of managerial careers. Administrative Science Quarterly, 1968, 13, 26-46.

Wallace, P., Kissinger, B., & Reynolds, B. Testing of minority group applicants for employment. In B.R. Anderson & M.P. Rogers (Eds.), Personnel testing and equal employment opportunity. Washington, D.C.: U.S. Government Printing Office, 1970.

White, H.C. Chains of opportunity. Cambridge, Mass.: Harvard University Press, 1970.

Wilkerson, D.A. Material requirements planning and manpower planning. Production and Inventory Management, 1976, 17 (2), 1-19.

APPENDIX A

Derivation of Predictor Mean Differences Between Blacks and Whites

Let $\overline{X}_t$ equal the mean of all predictor scores, and let $\overline{Y}_t$ equal the mean of all criterion scores. If scores are transformed so that all within-race predictor and criterion variances are equal, s^2 can equal the within-race variance on both X and Y. Let s_{tx}^2 equal the variance of the total X-score distribution and s_{ty}^2 equal the variance of the total Y-score distribution.

Constant Ratio Model

The constant ratio model specifies:

$$r_{cx} = r_{cy} \qquad \text{(A-1)}$$

Since c is a dichotomous variable, both correlations are point-biserial. Therefore:

$$(\overline{X}_w - \overline{X}_t)\sqrt{p_w/p_b}/s_{tx} = (\overline{Y}_w - \overline{Y}_t)\sqrt{p_w/p_b}/s_{ty}$$

$$(\overline{X}_w - \overline{X}_b)\sqrt{p_w p_b}/s_{tx} = (\overline{Y}_w - \overline{Y}_b)\sqrt{p_w p_b}/s_{ty} \qquad \text{(A-2)}$$

$$(\overline{X}_w - \overline{X}_b)/s_{tx} = (\overline{Y}_w - \overline{Y}_b)/s_{ty}$$

$$d = \Delta s_{tx}/s_{ty} \qquad \text{(A-3)}$$

Note that validity, r_{xy}, is not a parameter in the constant ratio model, and also note that $p_w = 1-p_b$, $\overline{X}_w = \overline{X}_b+d$, and $\overline{Y}_w = \overline{Y}_b+\Delta$. Then, since $\sum X^2 = N(s_{tx}^2 + \overline{X}_t^2)$ and $\sum Y^2 = N(s_{ty}^2 + \overline{Y}_t^2)$:

$$s_{tx}^2 = p_b(s^2+\overline{X}_b^2)+(1-p_b)[s^2+(\overline{X}_b+d)^2]-[p_b\overline{X}_b+(1-p_b)(\overline{X}_b+d)]^2$$

$$s_{ty}^2 = p_b(s^2+\overline{Y}_b^2)+(1-p_b)[s^2+(\overline{Y}_b+\Delta)^2]-[p_b\overline{Y}_b+(1-p_b)(\overline{Y}_b+\Delta)]^2$$

These reduce to:

$$s_{tx}^2 = s^2 + p_b d^2 + p_b^2 d^2$$

$$s_{ty}^2 = s^2 + p_b\Delta^2 + p_b^2\Delta^2$$

From equation (A-3):

$$d^2 = \Delta^2 (s^2 + p_b d^2 + p_b{}^2 d^2) / (s^2 + p_b \Delta^2 + p_b{}^2 \Delta^2)$$

Squaring both sides and reducing yields:

$$d = \Delta \qquad \text{(A-4)}$$

Regression Model

The regression model specifies:

$$r_{cx} = r_{cy}/r_{xy} \qquad \text{(A-5)}$$

Note that the derivation for the constant ratio model applies, with the right-hand side of each equation between (A-1) and (A-4) divided by r_{xy}. Therefore, $d = \Delta/r_{xy}$.

Conditional Probability Model

The conditional probability model specifies:

$$r_{cx} = r_{cy} r_{xy} \qquad \text{(A-6)}$$

Following the logic for the regression model gives $d = \Delta r_{xy}$.

Culture-Free Model

The culture-free model specifies:

$$r_{cx} = 0 \qquad \text{(A-7)}$$

Then:

$$(\bar{X}_w - \bar{X}_t) \sqrt{p_w/p_b} / s_{tx} = 0$$

$$d = 0$$

Color-Blind Model

The color-blind model makes no adjustment in X scores. Therefore, Δ does not constrain d. This means that there is no Δ parameter as well as no r_{xy} parameter in the model. Inspection of the equations between (A-1) and (A-4) shows,

then, that the color-blind model is structurally equivalent to the constant ratio model, but with Δ replaced by d. In other words, to find the impact of the color-blind model, one examines the impact of the constant ratio model, but replaces the criterion mean difference parameter with a predictor mean difference parameter.

Table 1

Five Definitions of Fair Selection

Definition	Correlational[b] Equivalent	Decisional[c] Equivalent
Regression model:[a] selection is fair when the prediction errors sum to zero for both groups. (Cleary, 1968)	$r_{cx} = r_{cy}/r_{xy}$	$\frac{I}{I + IV}$
Constant ratio model: selection is fair when the selection ratio is proportional to the success ratio across the groups. (Thorndike, 1971)	$r_{cx} = r_{cy}$	$\frac{I + II}{I + IV}$
Conditional probability model:[a] selection is fair when successful applicants have the same probability of selection in both groups. (Cole, 1973)	$r_{cx} = r_{cy}r_{xy}$	$\frac{I}{I + II}$
Culture-free model: selection is fair when the selection ratios are equal between the two groups.	$r_{cx} = 0$	$\frac{I + IV}{I + II + III + IV}$
Quota model: selection is fair when the proportion of selected applicants belonging to each group equals the group's quota proportion, q.		$\frac{I + IV}{q}$

---

[a]The regression model reduces to its decisional equivalent and the conditional probability model to its correlational equivalent when the conditions in footnote 1 are met (see Breland & Ironson, 1976; Peterson & Novick, 1976; Linn, 1973).

[b]From Darlington (1971) and Cole (1973); c="culture" variable (e.g., minority/non-minority), x=predictor score, y=criterion score.

[c]Taken in part from Petersen & Novick (1976). The decisional equivalent of each definition is to equalize the indicated ratio for each group. The Roman numerals refer to the regions of the predictor/criterion space as follows:

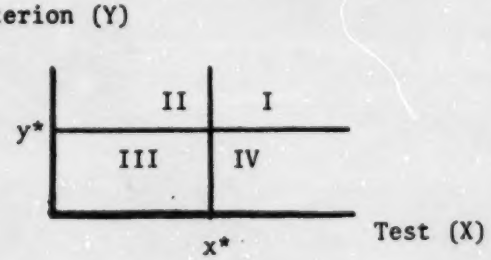

Table 2

Initial Staffing Levels and Transition Probabilities

	from initial job = i	initial staffing level	TRANSITION PROBABILITY TO JOB = j|i official/ admin.	professional	technical	clerical	termination
WHITE	official/ admin.	23	780[a]	055	022	000	110
	professional	156	006	848	022	000	123
	technical	239	000	038	844	002	105
	clerical	262	000	004	014	797	195
BLACK	offical/ admin.	0	780[b]	055[b]	022[b]	000[b]	110[b]
	professional	1	000	950[b]	000	000	050[b]
	technical	13	000	000	795	000	205
	clerical	129	000	000	011	820	165

[a] decimals omitted in transition probabilities

[b] observed figures were changed to produce the figures shown here, as discussed in text

Table 3

30-Year Black Employment Forecasts for the Internal-External Integrated Model at $\Delta = 0.5$[a] and $p_b = .225$

selection ratio	job class	fairness definition	$r_{xy} = .30$ year: 0	5	10	15	20	25	30	$r_{xy} = .50$ year: 0	5	10	15	20	25	30
.20	official/ admin.	regression	000[b]	003	003	003	003	003	003	000	020	021	021	021	021	021
		constant ratio	000	065	078	081	081	082	082	000	065	078	081	081	082	082
	profes- sional	regression	006	005	005	004	004	004	004	006	027	036	040	042	042	043
		constant ratio	006	073	112	136	151	160	166	006	073	112	136	151	160	166
	tech- nical	regression	052	035	025	022	021	021	021	052	052	067	078	085	088	090
		constant ratio	052	079	098	120	133	141	145	052	070	098	120	133	141	145
	cler- ical	regression	330	146	071	041	029	024	021	330	171	108	083	073	069	068
		constant ratio	330	217	174	157	151	149	148	330	217	174	157	151	149	148
.50	official/ admin.	regression	000	011	011	011	011	011	011	000	040	043	043	043	043	043
		constant ratio	000	084	103	107	108	108	108	000	084	103	107	108	108	108
	profes- sional	regression	006	016	017	017	017	017	017	006	053	074	084	089	092	093
		constant ratio	006	094	146	178	197	210	218	006	094	146	178	197	210	218
	tech- nical	regression	052	060	075	081	083	084	084	052	078	119	146	159	166	169
		constant ratio	052	085	124	141	166	175	180	052	085	124	151	166	175	180
	cler- ical	regression	330	167	101	075	064	060	058	330	206	157	138	131	128	127
		constant ratio	330	243	210	198	193	192	191	330	243	210	198	193	192	191

[a] when d = 0.5 instead of $\Delta = 0.5$, the constant ratio forecasts become the color blind forecasts

[b] proportion of the job class that is black, decimal omitted

Table 4

30-Year Black Employment Forecasts

for the Internal-External Integrated Model:

Culture Free Definition at all Values of Δ

and all Definitions at Δ = 0.0[a]

(p_b = .225)

job class	year 0	5	10	15	20	25	30
official/ admin.	000[b]	145	196	215	221	223	224
profes- sional	006	138	222	276	311	333	348
tech- nical	052	089	119	140	152	160	165
cler- ical	330	279	262	255	253	253	252

[a]forecasts are the same for all values of the validity and selection ration parameters

[b]proprotion of the job class that is black, decimal omitted

Table 5

Hiring Quota Forecasts:

10-Year Horizon, External Integrated Model

job class	quota ratio[a]	year 0	1	2	3	4	5	6	7	8	9	10
official/ admin.	.225	000[b]	040	072	097	116	132	144	153	161	167	172
	.500	000	090	160	216	261	296	325	347	366	380	392
profes- sional	.225	006	025	042	059	075	090	104	117	130	141	152
	.500	006	047	087	124	160	193	224	253	280	305	328
tech- nical	.225	052	074	092	107	118	128	135	141	146	150	153
	.500	052	108	155	195	229	257	281	301	318	332	344
cler- ical	.225	330	315	303	293	285	279	274	269	266	263	261
	.500	330	370	402	427	448	465	479	490	498	505	511

[a] the ratios are the proportions of new hires that must be black. A .225 ratio is a hiring quota equal to the population proportion.

[b] proportion of the job class that is black, decimal omitted